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In This Issue

Since its start in 1949, *Agricultural Economics Research* has had eight economics editors: Howard L. Parsons (1949-51), Herman M. Southworth (1951-55), James P. Cavin (1955-60), Rex F. Daly (1960-66), Ronald L. Mighell (1966-70), Allen B. Paul (1970-76), Clark Edwards (1976-83), and Lorna Aldrich (1983). With this issue I join this distinguished group, holding feelings of awe inspired by the intellectual and professional stature of the previous editors and humility inspired by the intellectual and professional quality of my fellow social scientists who form the pool of authors, reviewers, and readers of this journal.

In the introduction to the April 1983 issue, Lorna Aldrich, starting her editorship, reviewed and discussed the journal's unchanging purpose as stated by O. V. Wells in the first issue. She concluded that the original purpose is still the proper one. I agree and intend to continue along the broad outlines given in her introduction. Dr. Aldrich has left the Department of Agriculture for the Department of Commerce and the staff of the *Survey of Current Business*. During her year's service as economics editor, she maintained the quality of the publication and managed to give the journal a slight macroeconomic flavor just when the agricultural economics profession was feeling a need to be aware of macroeconomic influences on agriculture. No small feat for a new editor! I am fortunate Clark Edwards continues to serve as a member of the editorial board, so his accumulated experience remains as a valuable and available resource.

In this issue, the readers are exposed to a surprisingly representative example of the nature of economic research as conducted by the Economic Research Service (ERS).

In the lead article, Plato and Gordon present an "economist's laboratory experiment." They use dynamic programming to analyze 900 combinations of private carryin and public stock levels of a commodity. These 900 dynamic programming solutions are used in simulating 500 replications of a commodity market over a 10-year planning period. From their results the authors are able to examine the probability of a public stockpiling program meeting various public commodity stockpiling objectives.

Young and Shortle, in the second article, analyze survey results. They employ a logit model to examine how the personal and economic characteristics of individual landowners and the institutional and physical characteristics of their farming operations influence conservation investments. Their results support the view that conservation investments may not simply be a business decision prompted by potential profit maximization but that individual landowner characteristics are important and will influence responses to voluntary programs.

In the last article, Crom modifies an existing ERS model to analyze an economic question for which neither direct data (survey) nor estimates of underlying economic parameters exist. The economic question, "Has consumer preference for meat changed?" itself implies a change in an underlying economic parameter. Because it will be several years before enough price-quantity observations exist to make a statistical determination of these potential changes in consumer preferences, Crom assumes they have changed, modifies the FAPSIM model to reflect this assumption, and simulates their impacts on the crop and livestock sectors and food consumers.

The Research Review section also reflects the diversity of ERS interests. Rovinsky reviews a conference proceedings on global modeling, *Groping in the Dark*, and Coyle reviews a book about an agricultural petition, *Beef in Japan: Politics, Production, Marketing and Trade.*

Gerald Schluter

In Earlier Issues

In the long view, the financial management of U.S. farms has gone through three phases. In Phase I, land was so cheap (almost free) that the goal of immediate and full ownership by farmers was unquestioned. In Phase II, land had acquired some value, but a prudent and industrious farmer could eventually become a debt-free owner. Now, in Phase III, land is so expensive that full ownership of an adequate farm is no longer a feasible goal. This evolution is causing us to begin to explore alternative goals. Investment in other factors of production may often represent a more profitable use of the farmer's limited financial resources.

Warren R. Bailey
Vol. 19, No. 1, Jan. 1967

. . . risk situations are those in which parameters (such as the mean and variance) of the probability distribution of outcomes can be established empirically; uncertainty situations are those in which such parameters cannot be objectively established. Thus, any study that attempts to estimate empirically "measures of variability" falls more nearly in the classical *risk* setting. In fact, by providing objective measures of the variability of outcomes, the researcher is attempting to transfer decision-makers from an *uncertainty* to a *risk* setting. Thus, rather than relying on a "subjective guess," the decision-maker receives quantitative estimates of variability to guide his actions.

Gerald W. Dean and Harld O. Carter
Vol. 12, No. 2, Apr. 1960

Stockpiling U.S. Agricultural Commodities with Volatile World Markets: The Case of Soybeans

By Gerald Plato and Douglas Gordon*

Abstract

This article examines two alternative U.S. stockpiling objectives in the context of volatile world markets. The first objective is to prevent the U.S. soybean price from falling below a support price and the second is to bound the U.S. soybean price by a set of support and release prices. A size limit of public soybean stocks is imposed and additional market intervention is not allowed. The first objective can be fulfilled more frequently and at less cost than the second. Both objectives are fulfilled too infrequently when market volatility increases, unless the distance between the support and release prices is increased.

Keywords

Buffer stocks, optimal storage, dynamic programming

The most common rule for operating a public stockpiling program for an agricultural commodity is to buy at a support price and to sell at a higher release price. The U.S. Government has used this stockpiling method for five decades. It is widely recognized that maintaining a support price above the average annual free market price is not always feasible unless supplies are sometimes controlled to prevent unacceptable accumulations of public stocks.

Economists have recently shown that maintaining a particular set of support and release prices is not always possible, even when the support price is less than the average annual free market price (*9, 10*).[1] That is, public stockpiling cannot indefinitely bound the market price by a set of support and release prices. This result, which is less widely recognized, is due to the random influence of weather on the sizes of sequential harvests. It is a mathematical certainty that a sequence of random weather outcomes will occasionally result in a sequence of harvests that will, in total, be too large to be consumed at a support price, even if the support price is less than the average market price, and public stocks will rise to unacceptable levels. Supply control measures can be used to head off an unacceptable accumulation of public stocks. However, this solution may be interpreted as a failure of the stockpiling scheme. It is also a mathematical certainty that a sequence of random weather outcomes will occasionally result in a sequence of harvests that will, in total, be too small to prevent depleting public stocks in the attempt to maintain price at the release level. There is no comparable method to supply control that will prevent market price from rising above the release price.

Although it is not always possible to bound the market price by a set of support and release prices, in most years it is possible to do so without further market intervention. The stockpiling objective may be to prevent the market price from falling below the support price rather than to bound it by the support and release prices. It is easier to fulfill the objective of only preventing price from falling below the support price. Price rising above the release level after the stockpile is depleted does not violate this objective.

Most investigations of public stockpiling have ignored the Government's inability to enforce a set of support and release prices. Gardner and Salant are noteworthy exceptions (*1, 9*). Salant implies that this problem suggests that stockpiling should not be

*The authors are agricultural economists with the National Economics Division, Economic Research Service. They thank Clark Edwards, Richard Heifner, and two anonymous reviewers for constructive reviews of previous drafts.

[1]Italicized numbers in parentheses refer to items in the References at the end of this article.

attempted. However, public stockpiling by use of support and release prices for an agricultural commodity which fulfills the stockpiling objective in most years could well be socially acceptable.

One can draw several general conclusions from the research of Gardner and Salant on the probability of enforcing the support and release prices over a planning period. The probability of avoiding failure over any given time period (1) will decrease as the market price becomes more variable, (2) will decrease as the level of the stockpile approaches zero or its maximum acceptable level, and (3) can be increased if the Government specifies lower support and higher release prices. These general conclusions provide little help to those who formulate public stockpiling policy. Information on the probability of fulfilling stockpiling objectives over a given planning period would be much more helpful. However, no studies have examined this probability, a significant omission given the prevalence of public stockpiling based on support and release prices.

Reliance on volatile foreign agricultural markets for marketing much of U.S. farm production implies a central concern with commodity stockpiling. Stocks can quickly reach unacceptable levels when foreign demand slackens. Domestic prices can also move outside the desired price range when the world situation suddenly shifts. Therefore, we need to understand the effects of alternative stockpiling procedures on developing a successful stockpiling policy.

This article examines the effects of alternative soybean support and release prices on the probability of fulfilling the public stockpiling objective over a 10-year period. The stockpiling objectives we examine include: (1) bounding the market price by support and release prices and (2) preventing the market price from falling below the support price. We assume no further market intervention to help fulfill either stockpiling objective. We pay particular attention to the influence of the variability of supply and demand on the probability of fulfilling the stockpiling objective. We also examine the public cost of stockpiling.

Method

Both Gardner and Salant used dynamic programming in their analyses of public stockpiling (*1, 9*). Rational expectations in private storage is assumed with the dynamic programming method, implying that participants in commodity storage correctly attempt to maximize their returns from storage, given the variability in supply and demand. This behavioral assumption is appropriate for investigating the probability of achieving the objective of public stockpiling. For example, when the stockpile is low, private storers find it profitable to buy the entire stockpile at the release price and either sell it all immediately at a higher price or sell part of it immediately at a higher price and store the remainder in anticipation of a higher price next year. This speculative attack, described by Salant, increases the probability that the stockpile will be drawn down to zero. When the stockpile level gets close to its maximum acceptable level, private storers correctly anticipate the increased probability of the market price falling through the support-price floor, and they decrease their level of stocks to avoid losses. This speculative attack also increases the probability that the stockpile will reach its maximum acceptable level. Private storage immediately increases after the price falls through the support-price floor because speculators can buy stocks at a lower price.[2]

The dynamic programming algorithm written for this study extends an algorithm formulated by Ippolito (*5*). Ippolito's algorithm solves for the optimal or rational level of private storage and for the rational level of production, given the current level of private storage. Producers and private storers correctly attempt to maximize their rate of return based on expectations of supply and demand. The extended algorithm includes public stockpiling with the possibility of failing to enforce the support and release prices. Failure occurs both when public stocks are low and are subsequently eliminated by a speculative attack and when stocks reach a maximum level. Stockpile sales are not possible when the stockpile level is zero. Stockpile purchases are also not possible when the stockpile is at its maximum level.

Our analysis is the first dynamic programming analysis of commodity storage that includes rational production simultaneously with private storage and

[2]The dynamic programming method includes both speculative and physical storage activities in the determination of the optimal or expected profit-maximizing levels of private carryover. An individual involved in private carryover, that is, in carrying a commodity from one harvest to the next, may be involved in physical storage or price speculation, or both.

with a public stockpiling program which can fail to enforce support and release prices. Both Gardner and Salant specified production as a random variable with a stationary mean.[3] The rational production decisions influence the probability of failing to achieve the stockpiling objective. As the public stockpile is drawn down, the expected price rises, reflecting the increased probability that the market price will break through the release-price ceiling. Producers increase their intended or expected production because of the higher expected market price, and thereby reduce the probability of the public stockpile being drawn down to zero. Conversely, as the public stockpile approaches its maximum acceptable level, the expected market price decreases, reflecting the increased probability that the market price will break through the support-price floor, and causes producers to reduce their intended production. This response reduces the probability that the stockpile will accumulate to its maximum acceptable level. Both production responses reduce the frequency of speculative attacks by private storers.[4]

The rational production response to the level of private carryover also decreases the probability that the stockpile will fail. The level of rational production decreases (increases) in response to a larger (smaller) private carryover from the previous year. These production responses reduce the amount of stockpile purchases and sales, thereby lowering the probability that the stockpile will fail to enforce the support and release prices over the planning period.

The expected production level at planting is found in the dynamic programming algorithm by solving equation (1) given the levels of private and public stocks. Thus, farmer expectations at planting become:

$$E(GOVSL_{m,n,t}) + C_{n,t-1} + E(PROD_{m,n,t}) = E(GOVPU_{m,n,t}) + E(C_{m,n,t}) + E(D_{m,n,t}) \quad (1)$$

$$m = 1, 2, ..., M$$

$$n = 1, 2, ..., N$$

where:

t = current year,

n = index for alternative levels of private carryin,

m = index for alternative levels of the public carryin (stockpile level),

$E(GOVSL_{m,n,t})$ = expected stockpile sales,

$C_{n,t-1}$ = private carryin (private carryover from the previous year),

$E(PROD_{m,n,t})$ = expected production $= \gamma + \delta\, E(P_{m,n,t})$,

$E(P_{m,n,t})$ = expected price,

$E(GOVPU_{m,n,t})$ = expected stockpile purchases,

$E(C_{m,n,t})$ = expected private carryover, and

$E(D_{m,n,t})$ = expected current year demand $= \alpha - \beta\, E(P_{m,n,t})$.

Both the levels of private carryin and the public stockpile are independent variables in the determination of the expected production level. The producers' expected production level, which is found by the dynamic programming algorithm, is the rational level because it equates total expected supply and demand. Other expected production levels result in either excess expected supply or demand. The level of the public stockpile may restrict the quantity of stockpile purchases and/or sales and may thereby influence the level of the rational producer response.

One can calculate the anticipated or expected values of the variables in equation (1) by taking their expectations in equation (2) over the possible outcomes, after harvest, for the supply minus demand random terms. Thus, private storage expectations at harvest become:

[3]The price expectations in production and in private storage are consistent when both are based on rational expectations. Because a producer may also be involved in private storage, this means that an individual's price expectations are consistent in both activities. However, an individual's price expectations in production are inconsistent with those in private storage when production is specified as a random variable and private storage is based upon rational expectations.

[4]The dynamic programming method allows the effects of the stockpile to be built into the price expectations and thereby into the responses of storers and producers. This method avoids the common problem of analyzing the effects of changing a "policy" parameter in an econometric model without considering the effects of the policy change on the underlying economic behavior (*6*).

$$C_{n,t-1} + E(PROD_{m,n,t}) + W_i$$

$$= -GOVSL_{h,t} + GOVPU_{j,t} + C_{k,t} + \alpha - \beta P_{i,t} \quad (2)$$

Given n and m:

$$i = 1, 2, ..., I$$

where:

$C_{n,t-1}$ = private carryin,

$PROD_t$ = $E(PROD_{m,n,t}) + v = \gamma + \delta E(P_{m,n,t}) + v$ = production outcome,

v = random term in supply equation,

$D_{i,t} = \alpha - \beta P_{i,t} + u$ = demand outcome,[5]

u = random term in demand equation,

$P_{i,t}$ = current year price,

W_i = midpoint of an interval on the probability distribution of the supply random term minus the demand random term (v − u),

i = index for the levels of W_i,

$Pr(W_i)$ = probability of W_i occurring,

$GOVSL_{h,t}$ = stockpile sales,

h = index for the levels of stockpile sales,

$GOVPU_{j,t}$ = stockpile purchases,

j = index for the levels of stockpile purchases,

$C_{k,t}$ = private carryover, and

k = index for the levels of private carryover.

Details on solving equations (1) and (2) without public stockpiling are provided in (*8*).[6]

[5]The random term in the demand equation, u, appears as a component of W_i on the left side of equation 2. The remainder of the demand equation appears on the right side of equation 2.

[6]The above notation is consistent with that in our earlier article to which the interested reader can refer to see how the algorithm solves equations (1) and (2).

Including public stockpiling involves the additional computation of adding to or subtracting from the public stockpile whenever necessary and possible to prevent the market price from falling below the support price and from rising above the release price. In addition, with public stockpiling included, equation (1) must be solved for each combination of private and public stocks because both influence the level of price and thereby influence demand and supply expectations. We used 30 levels of private stocks and 30 levels of public stocks, or a total of 900 combinations (n, m = 1, ..., 30). Omitting public stockpiling would mean that equation (1) would be solved 30 rather than 900 times.[7] Ippolito's method of finding the rational production response allows the computations to be kept at an acceptable level (*5, 8*). Using the traditional dynamic programming approach and including 30 levels of production in addition to 30 levels of public and of private stocks would most likely require a prohibitive computational load. The traditional approach would consider 30 × 30 × 30, or 27,000 combinations rather than 900. This example demonstrates the curse of dimensionality in dynamic programming.

We used the dynamic programming solutions for each of the 900 combinations of private carryin and public stock levels in simulating 500 replications of the soybean market over a 10-year planning period. The simulation procedure involves specifying initial levels of private carryin and public stocks and then calculating a value of W_i from randomly drawn values for u and v. The level of stockpile sales and purchases and of private carryover associated with the random value for W_i are taken from the dynamic programing results in equation (2). The rational production response, given the levels of private carryin and public stocks, is also taken from the dynamic programming results. We calculated values for the current year's price, demand, production, and stockpile revenues and costs using the randomly drawn values for u and v and the dynamic programming results. Using the stockpile sales or purchases, we then calculated an updated level of the stockpile which may be zero or its maximum acceptable level.

[7]In an earlier dynamic programming analysis of public stockpiling, we assumed that public stocks would always be available and that accumulation to large stock levels would not be a problem (*3*). This assumption meant that the market price could always be bounded by the support and release prices. It also meant that the level of public stocks did not influence demand and supply expectations. In the context of this discussion, this implies that only 30 solutions are required rather than 900 solutions.

This updated stockpile level and the level of private carryover provide the initial conditions for the following year.

Preparations for Analysis

If the stockpiling objective is to prevent the market price from falling below the support price and from rising above the release price, then it may be desirable to make the frequencies of running out of and accumulating public stocks to an unacceptable level approximately equal. However, this task is difficult. Setting the support and release prices equidistant from the annual average price is a simple specification. But, with private carryover involved, this specification makes running out of public stocks more frequent than accumulating them to an unacceptable level.

The private carryover resulting from a large current-year harvest and/or small current-year demand reduces the quantity of stockpile purchases required to maintain the market price at the support level. However, part or all of this private carryover is frequently sold at a price less than the release price and, hence, may not be available when needed to help maintain the market price at the release level. This private storage behavior implies that one must make the release price easier to defend by setting it at a greater distance from the average annual price than the support price so as to prevent drawing down public stocks to zero more frequently than accumulating them to an unacceptable level. How much farther cannot be determined analytically. However, one can experiment with several levels of the release price relative to a particular support price in our dynamic programming algorithm to make the frequency of the two methods of stockpile failure nearly equal.

If the stockpiling objective is to prevent severely depressed market prices, particularly after harvest, then specifying the support and release prices equidistant from the mean price may be adequate. Running out of public stocks would occur more frequently than would accumulating them to an unacceptable level. However, running out of public stocks is not a stockpiling failure with this objective; accumulating them to an unacceptable level is.

Soybean supply and demand elasticity estimates were derived from Gordon (*2*). Both elasticity estimates were 0.5. We converted these elasticity estimates to slope parameters by using a market equilibrium level of 2.268 billion bushels, the 1979 U.S. production of soybeans (table 1). Because the slope parameters measure the response to price in 1972 dollars, the prices in the analysis are also in 1972 dollars.

Table 1—Parameters used in dynamic programming algorithm and in computer simulations with the dynamic programming results

Item	Equation	
Supply equation[1]	Prod	$= \gamma + \delta E(p) + v$
	γ	= 1,134
	δ	= 298.4
	Standard deviation of v	= 245
Demand equation[1]	D	$= \alpha - \beta p + u$
	α	= 3402
	β	= 298.4
	Standard deviation of u	= 173.0
	Standard deviation of u′	= 377.5
"State of the world"[2]		
$W = v - u$	Standard deviation of W	$= v - u = 300$
$W' = v - u'$	Standard deviation of W′	$= v - u' = 450$
Annual storage charges	$0.30 per bushel	
Interest rate for discounting from next year to current year	10	

[1]Parameters in the supply and demand equations represent millions of bushels.
[2]The standard deviations of the random-error terms u′ and w′ represent increases of 118 percent and 50 percent above their estimated historical levels.

The estimates of the standard deviation of the random supply and demand terms were also taken from Gordon (*2*). The higher standard deviation of $W'_i(v - u')$ used in the analysis represents a 50-percent increase in overall market variability and is assumed to be due solely to increased demand variability. This assumption is consistent with O'Brien's view of the possibility of another doubling of export demand variabilities in the eighties (*7*).

The error terms u and v are assumed to be independent and normally distributed; consequently, W_i is also normally distributed. To make W_i operational

in the dynamic programming algorithm, we truncated at plus and minus 2.5 standard deviations and calculated probabilities for intervals of equal width over the truncated distribution. We used 60 intervals when W_i was set at a standard deviation of 300 million bushels and 90 intervals when W_i was set at a standard deviation of 450 million bushels. The midpoints of the intervals were used for the values of W_i in the dynamic programming algorithm and the computer simulations.

We made private carryover and the public stockpile operational in the dynamic programming algorithm by specifying them as discrete variables. Each was given 30 levels from zero to 725 million bushels in increments of 25 million bushels. These levels correspond with m, n = 1, 2, ..., 30 in equations (1) and (2).

This specification of the stockpile makes the stockpile purchases and sales discrete with the same 25-million-bushel increments. The maximum level of stockpile purchases and sales depends on the level of the stockpile.

The Analysis

The analysis examines the effects of setting the support price at one standard deviation below mean price and the release price at several alternative levels above mean price. It also examines the effects of a 50-percent increase in overall market variability and the effects of the initial public stockpile level (table 2).

Computer simulation based on the results from a version of the dynamic algorithm that omits public stockpiling (Ippolito's algorithm) estimated the mean and standard deviation of the market price to be $3.79 and $0.76 per bushel, respectively, when demand variability was set at the historical level (case 1). Initially, the release and support prices were set at $4.55 and $3.03 per bushel, $3.79 ± 0.76, and were used in the public stockpiling version of the dynamic programming algorithm. We used these results along with a beginning level of private carryin and public stocks set at 375 million

Table 2—Public stockpiling outcomes for selected combinations of support and release prices, market variability, and beginning stockpile levels

Case	σ_w[1]	Support price[2]	Release price[2]	Beginning stockpile	Probability of failing to enforce		Average annual price[4]	Average annual stockpile returns[5]
					Support price[3]	Release price[3]		
	Million bushels	*Dollars/bushel*		*Million bushels*			*Dollars/bushel*	*Million dollars*
1	*300*	*0*	*∞*	*—*	*—*	*—*	3.79	*—*
							(.76)	
2	300	3.03	4.55	375	0.05	0.30	3.74	−115
		(1)	(1)		(27)	(150)	(.63)	(405)
3	300	3.03	4.69	375	.06	.22	3.75	−144
		(1)	(1.25)		(28)	(111)	(.65)	(376)
4	300	3.03	4.93	375	.13	.07	3.77	−226
		(1)	(1.50)		(64)	(35)	(.67)	(335)
5	300	3.03	4.55	200	.01	.48	3.78	−56
		(1)	(1)		(5)	(240)	(.67)	(316)
6	450	3.03	4.69	375	.34	.46	3.76	−121
		(0.75)	(0.84)		(171)	(231)	(.82)	(639)
7	450	0	∞	—	—	—	3.79	—
							(1.01)	
8	450	2.77	5.07	375	.05	.34	3.76	−77
		(1)	(1.25)		(26)	(172)	(.89)	(431)

— = Not applicable. ∞ = Infinity.
[1] Standard deviation of the difference between the supply equation and demand equation error terms.
[2] Numbers in parentheses are the distances from the estimated free market average price in terms of standard deviation.
[3] Numbers in parentheses are the number of failures in 500 replications.
[4] Numbers in parentheses are the standard deviations of annual price.
[5] Numbers in parentheses are the standard deviations of the annual stockpile returns.

bushels to simulate 500 replications of the soybean market over a 10-year period (case 2).

The simulation procedure estimated that the probability of not being able to enforce the release price as a result of drawing the public stockpile down to zero over the 10-year period was 0.3 The corresponding probability for not being able to enforce the support price as a result of accumulating public stocks to the maximum level was 0.05. This result is consistent with the earlier contention that public stocks will be drawn down to zero more frequently than will accumulating them to an unacceptable level when the support and release prices are equidistant from the mean price.

The probability of running out of public stocks and of not being able to enforce the release price for a given year increased annually over the 10-year period. Toward the end of the period, this probability was large relative to the probability of not being able to enforce the release price over the entire 10-year period. For example, the probability of not being able to enforce the release price in year 5 was 0.10. For year 10, this probability was 0.22. The reason for the rise is the tendency of failures to follow failures. With no public stocks available at the end of year t, the probability of not being able to enforce the release price in year t + 1 is greatly increased. That failures tend to follow failures was made more evident when we reduced beginning public stocks from 375 to 200 million bushels (case 5). With fewer public stocks available, the rate of not enforcing the release price was increased in the early years. For year 10, the probability of failing to enforce the release price had risen to 0.36.

Although depleting public stocks was more frequent than was accumulating them to the maximum level of 725 million bushels, the stockpile losses averaged $115 million annually (case 2). However, the standard deviation of the annual amounts earned and lost by the stockpile was $405 million, or nearly four times the absolute value of the average annual amount lost. The high variability of the annual losses relative to their average level indicates that the stockpile at times earned considerable profits and was a risky venture.

The reason for the stockpile losing money on average is that the operating rule of buying at the support price and selling at the release price is a suboptimal rule for making a positive rate of return from storage (*1*). The optimal storage rule varies the amount of carryover according to the level of the current price and of next year's expected price. Gustafson showed that the optimal storage rule corresponds to the profit-maximizing carryovers in a competitive market (*4*).

Although the stockpile frequently failed to enforce the release price, the standard deviation of market price was reduced to $0.63 per bushel (case 2), a 17-percent decrease from case 1 which had no public stockpiling.

If the stockpiling objective is only to prevent the market price from falling below the support price, then specifying the release and support prices at plus and minus one standard deviation from the mean price may be judged favorably. With this objective, the probability of the stockpile failing over the 10-year period is 0.05 when the beginning stockpile level is 375 million bushels (case 2). With a beginning stockpile level of 200 million bushels, this probability drops to 0.01 (case 5) because a larger accumulation of public stocks is required to reach the maximum level. A release price less than $4.55 per bushel could reduce the probability of accumulating stocks to the maximum level because public stocks would be sold more frequently. However, private carryover would be reduced as a result of the smaller distance between the release and support prices, thus requiring larger stockpile purchases and consequently a more expensive stockpile.

A better balance between the rates of running out of public stocks and accumulating them to the maximum level is desirable, if the stockpiling objective also includes protecting consumers from high prices. We used release price levels of 1.50 and then 1.25 standard deviations above mean price with the support price remaining at 1.0 standard deviation below mean price in an attempt to get a more balanced stockpile.

The release price of $4.93 per bushel, or 1.5 standard deviations above the mean price, unbalanced the stockpile in the other direction (case 4). The probability of failing to enforce the release price over the 10-year period is 0.07. The corresponding probability of failing to enforce the support price is 0.13. Furthermore, the average cost of the stockpile compared with case 2 increased from $115 million

to $226 million annually. The increased costs were due to the tendency to accumulate more stocks.

The release price of $4.69 per bushel, or 1.25 standard deviations above mean price, also tended to draw down stocks (case 3). With this release price, the probability of depleting public stocks and not being able to enforce the release price over the 10-year period was 0.22. The probability of accumulating public stocks to the maximum level and not being able to enforce the support price was 0.06.

This experiment with different levels of the release price demonstrates the difficulty of achieving a balanced stockpile even when all parameters are known. The perfectly balanced stockpile for the parameters used has a release price between $4.69 and $4.93 per bushel. However, one needs additional solutions of the dynamic programming algorithm and corresponding computer simulations to find the exact release price.

We used support and release prices of $3.03 and $4.69 per bushel with the higher level of overall market variability ($\sigma_w = 450$) to examine the influences of greater market variability on public stockpiling and to examine the need for re-specifying the support and release prices (case 6). Beginning levels of private carryin and public stocks for simulating market outcomes over a 10-year period were maintained at 375 million bushels. The probability of failing to enforce the release price over the 10-year period is 0.46. The corresponding probability of failing to enforce the support price is 0.34. These probabilities are 108 percent and 511 percent larger, respectively, than those with the lower level of demand variability (case 3). These failure rates would probably be considered unacceptably high.

Under the high level of demand variability, the annual cost of the stockpile was estimated at $121 million (case 6). This estimate is a 16-percent decrease compared with the low or historical level of demand variability (case 3). The more frequent stockpile sales outweighed the more frequent stockpile purchases. The standard deviation of the market price also increased from $0.65 to $0.82 per bushel because of both the higher level of market variability and the higher frequencies of depleting public stocks and accumulating them to the maximum level.

The standard deviation of the market price was estimated at $1.01 per bushel for the higher level of demand variability without public stockpiling (case 7). This is 33 percent higher than the $0.76-per-bushel standard deviation for the historical level of demand variability without public stockpiling (case 1). Without private carryover, the standard deviation of price would have increased by a larger amount. The mean price was $3.79 per bushel, the same as under the historical level of demand variability.

Under the high level of demand variability, the support price of $3.03 is 0.75, rather than 1.0, standard deviation below the mean price. The release price of $4.69 is 0.89, rather than 1.25, standard deviation above mean price. We reset the release and support prices at $5.07 and $2.77 per bushel (plus 1.25 and minus 1.0 standard deviations from the mean price) to reduce the rate of stockpile failure (case 8). This specification of the release and support prices resulted in the probability of failing to enforce the release price of 0.34 over the 10-year period and a corresponding probability of failing to enforce the support price of 0.05. The probability of failing to enforce the support price is 17 percent lower than under the historical level of demand variability (case 3). However, the probability of failing to enforce the release price was 55 percent higher than in case 3.

The cost of the stockpile under the high level of demand variability averaged $77 million annually (case 8). It is surprising that the average stockpiling cost is 47 percent less than under the historical level of demand variability (case 8 versus case 3). This result is explained by the larger levels of private carryover and the smaller levels of stockpile purchases. Private carryover increased by 198 percent because of the greater distance between the release and support prices ($5.07-$2.77 versus $4.69-$3.03) and because of the larger level of market variability (case 8 versus case 3). These two factors provide larger and more frequent profit opportunities for private carryover.

The increase in private carryover and the decrease in stockpile purchases were responsible for the large decrease in the probability of failing to enforce the support price relative to the probability of failing to enforce the release price (case 8 versus case 6). Stockpile purchases were replaced by the larger levels of private carryover, thereby reducing the frequency of

the stockpile accumulating to the maximum level. However, as explained earlier, private carryover is frequently sold at less than the release price, thus making this source of stocks undependable for enforcing the release price. Therefore, the effect of the higher, and consequently less difficult to enforce, release price was partially offset by having fewer reliable stocks with which to do the enforcing.

Without private carryover involved, the probabilities of failing to enforce the release and support prices would have decreased by approximately the same amounts. This example demonstrates that the influences of private carryover cannot be omitted when one examines public stockpiling.

Conclusions

There is a much larger margin for error in setting the support and release prices when the stockpiling objective is only to prevent the market price from falling below a support price than when the stockpiling objective also includes preventing the market price from rising above a release price. With the first objective, a relatively large range of release prices is compatible with the tendency to deplete the stockpile as long as the support price is less than the average annual market price. If stocks do not tend to accumulate with the first objective, then the support price can generally be maintained without the use of supply control measures to stop the stockpile from accumulating to unacceptable levels. Either the tendency to deplete or the tendency to accumulate stocks with the second objective results in a large failure rate. It is difficult to prevent both tendencies simultaneously.

With the first objective, the overall rate of failure can be kept below 5 percent over a 10-year period, while the support price is maintained at 1.0 standard deviation below the average annual mean price. For the second objective, the most balanced stockpile (support and release prices at $3.03 and $4.93, respectively) has an overall failure rate of 20 percent over a 10-year period (case 3). A perfectly balanced stockpile would have a lower overall failure rate because there would be no tendency to deplete or to accumulate stocks. However, the goal of achieving a balanced stockpile is difficult to accomplish. If an error is made on the side of accumulating stocks in the attempt to achieve the balanced stockpile, the average annual cost of the stockpile will be large.

The support price can be decreased and the release price increased when the market becomes more variable to prevent an unacceptable rate of stockpile failure. This correction is less difficult if the stockpiling objective is only to prevent the market price from falling below the support level.

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Investments in Soil Conservation Structures: The Role of Operator and Operation Characteristics

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Abstract

Targeting soil conservation programs to specific problem areas implies that individual landowners are targeted for program participation. A better understanding of how the characteristics of individual landowners and their farm operations influence conservation investments can help policymakers design more effective voluntary conservation programs. This article uses the estimates of a logit model to study how these relationships apply to soil conservation structures.

Keywords

Soil conservation, owner characteristics, logit

The Soil and Water Resources Conservation Act (RCA) of 1977 directed the Secretary of Agriculture to appraise the condition of the Nation's soil and water resources and to develop a national program to guide the conservation programs of the U.S. Department of Agriculture (USDA). As a result of this assessment, USDA is redesigning its soil conservation programs to focus on specific problem (targeted) areas, thereby achieving greater conservation gains at lower costs.

It now seems that the voluntary approach, which characterizes erosion control policy, will be a principal feature of future initiatives. The success of these initiatives will, therefore, depend on their ability to elicit effective voluntary responses from farm decisionmakers in targeted areas. The problem of encouraging farmers to voluntarily use conservation practices is essentially a technique-adoption problem. Farm operations are highly complex entities, and adoption research generally suggests that individual characteristics influence observed adoption decisions (*7*).[1] This research also suggests that the use of information on relationships between these characteristics and observed behavior can enhance public policies encouraging adoption. Thus, an understanding of how individual characteristics tend to influence conservation decisions can improve the effectiveness of voluntary soil conservation programs in targeted areas.

In this article, we present the results of our investigation of the relationship between investment in conservation structures and the characteristics of farm decisionmakers and their operations. We emphasize the potential complementarity between investments in conservation structures and other land improvement investments. The results are based on a logit probability model.

Background

Most previous research on conservation practices has employed operations research methods (*5*). Inherent in these studies is the assumption that farm decisionmakers are not only profit maximizers but also equally competent profit maximizers. This assumption implies that the characteristics of individuals have no bearing on investment behavior. However, characteristics do have a bearing for the simple reason that individuals are not uniformly alike; they vary in management skills and management objectives. This observation is not important to policy analysis and policy design if the behavior of individuals in target areas is consistent with the behavioral responses inferred from models of representative profit-maximizing enterprises. However, it is argued that individual characteristics are important and do influence responses to voluntary programs (*12*).

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[1]Italicized numbers in parentheses refer to items in the References at the end of this article.

The proposition that individual characteristics are important has led to an alternative line of research focusing on observed, rather than assumed, behavior. Work in this area is just now getting underway, partly because of a severe scarcity of data on the characteristics of individual farm decisionmakers and their use of conservation practices and structures (*2, 6, 8, 10, 12, 13*).

The major feature of this research is its positive nature. The research attempts to relate observed behavior to observable characteristics of farm decisionmakers and their operations. Analysts have generally classified these characteristics as personal, physical, institutional, and economic (*6, 8*). Personal variables are included to allow for variation in human capital and management objectives. For example, years of formal schooling often serve as a proxy for management skills. Age is often used to reflect life cycle considerations under the hypothesis that individuals' management objectives vary throughout their lives. Physical factors, principally measures of the erosivity of farmland, are included under the assumption that conservation practices are adopted to diminish erosion problems and are, therefore, more likely on more erosive land. The benefits and costs of such investments are contingent upon economic characteristics of the farm operation and institutional factors. Consequently, these studies also include variables reflecting economic characteristics, such as farm size, farm income, and institutional factors.

Previous research on the adoption of conservation measures has focused on nonstructural practices. Our study focuses on structural practices. We generally propose that the factors identified in the research on adoption of nonstructural practices will also affect the adoption of structural practices. To specify the model, we adopted a variables list analogous to that in previous research. We expanded this list to include other land-improving investments. Structural measures often entail major expenditures of funds, substantial modifications in the logistics of farm management, and careful prior planning. Other land-improving investments compete for investment funds. Conversely, landowners who are upgrading their land resources through investments, such as clearing and draining land, may find that concurrent investments in conservation structures are complementary. Conservation investments will naturally tend to protect the improved land resource. Cost savings may also be encountered through simultaneous construction.

Model Specification and Regression Data

Linear probability models estimated by ordinary least squares are common in the agricultural and general adoption literature because these models permit researchers to relate the probabilities of individual adoption to relevant characteristics based on the common types of data on adoption—that is, on binary data indicating that an individual either has or has not adopted. However, the use of linear models poses a number of difficulties. The logit type of probability model has found increasing use because it overcomes the more serious of these difficulties. The logit model is of the form:

$$P_i = \frac{1}{1 + e^{-Z_i}}$$

where:

P_i = the probability of individual i choosing one or two options

and:

$$Z_i = \sum_{k=1}^{m} \beta_k X_{ik}$$

where:

X_{ik} = the value of the kth attribute of the ith individual.

In this analysis, P_i is the probability of adoption of conservation structures and the attributes are individual and farm characteristics.

We derived data for this analysis from the Landownership Survey (LOS) which the Natural Resource Economics Division of the Economic Research Service conducted in 1978. The LOS was a nationwide survey providing information on characteristics of landowners. Daugherty and Otte summarized survey results for farmland owners, while Lewis summarized the results for all landowners (*4, 11*).

LOS respondents were asked whether or not they invested in a soil conservation structure (for example, terrace, grass waterway, or gully control structure) during the 1975-77 period. The survey covered more than 1 year to improve the reliability of the survey. A subsample of those landowners who invested in a conservation structure was re-surveyed to determine the nature of their investments. Of those landowners investing in soil conservation structures, 46 percent installed grass waterways, 41 percent installed gully control structures, and 27 percent installed terraces (*15*).

Of the estimated 6.9 million owners of farmland in the contiguous United States, 8.4 percent invested in at least one type of soil conservation structure in the 1975-77 period. Most of these owners lived in the Corn Belt; the fewest lived in the Lake States. Average farm size for landowners who invested in soil conservation structures was generally twice that for other farmland owners.

The dependent variable is whether or not a farmland owner invested in a soil conservation structure between 1975 and 1977. The regressors are characterized as personal, economic, institutional, and physical factors (*6, 8*). A subsample of 14,600 owners was selected from the LOS. About 45 percent of the original data from the LOS were excluded from the analysis because of nonresponse to critical questions such as value of farmland, income, and conservation investment. Our examination of means, medians, ranges, and variances of the full data and the reduced data did not reveal major differences.

Personal Factors

The age of the landowner was included in the model to represent life cycle impacts on investment behavior. Age may also reflect experience and the vintage of knowledge attained by formal education. The years of formal education are also included in the model. Higher levels of formal education are assumed to reflect greater management capabilities and a better understanding of the benefits and costs of soil conservation. The sex of the landowner was also included.

Economic Factors

A variety of data are available representing the economic situation of the farmland owner. Farm income is entered as the midpoint of an income range. The value of farmland is entered on a per-acre basis. These variables are included to represent the landowner's ability to finance conservation investments.

The use of owner and rented lands for crop production influences the likelihood of conservation investments (*1, 8*). The following four variables represent tenure relationships: acres of farmland owned, acres of farmland rented from others, acres of farmland rented to others, and the use of share leases for land rented to others. Banks and others concluded that farm operators who utilize share leases are more likely to use less erosive practices (*1*).

We evaluated the influence of other complementary investments occurring simultaneously with conservation investment by using three zero-one variables for land clearing, land draining, and converting land to cropland. These variables indicate whether or not these other types of land improvements were made.

Institutional Factors

The only institutional factor for which data are available is whether or not a portion of the landowner's land is enrolled in a special property tax assessment program. Participation in a special assessment program was measured in a "yes-no" format.

Physical Factors

The primary physical factor influencing investments in soil conservation structures is erosivity of the land in question. Through a merger of LOS data with Soil Conservation Service's National Resource Inventory (NRI) data, we derived an estimate of soil erosion for the NRI sampling point. The erosion estimate is based on the Universal Soil Loss Equation (USLE) (*17*). However, there is no reason to expect that conservation investment occurred on the same parcel of land for which the erosion estimate was computed. In a large data set such as the LOS, an erosion estimate for a point will probably fairly represent the average erosion for the entire farm.

We included the farm production regions of the Nation to account for broad differences in topography, climate, and agricultural practices (see figure). The regions were entered as dummy variables, and the Lake States were omitted as a variable.

Farm Production Regions

Results

The table presents the regression results. The parameters for the clear, drain, and convert variables are positive and significant. The large magnitude of the chi-square statistics on the clear and drain variables indicate an association between investments in conservation structures and other land-improving investments. Furthermore, the positive signs on the clear, drain, and convert parameters suggest the relationship is complementary. That is, conservation investments tend to be more likely when other land-improving investments are undertaken. One policy implication of this finding is that programs encouraging the adoption of soil conservation structures may be more successful if accompanied by incentives encouraging land improvement. Furthermore, when areas are targeted for program efforts, it may help to know the degree to which other land-improving investments are economically feasible and socially desirable.

The parameters for age, education, and sex are statistically significant. Therefore, these results support the hypothesis that the characteristics of individuals do affect investment behavior. Of particular importance for policy design is that individuals with more years of formal education are more likely to invest in conservation structures.

Regression results

Variable	Parameter estimates and X^2 statistics
Intercept	−3.490[1]
	(259.24)
Age	−.009[1]
	(19.80)
Education	.062[1]
	(54.23)
Sex (male = 1)	.346[1]
	(15.41)
Farm income	$.13 \times 10^{-5}$
	(.01)
Land value ($1,000/acre)	−.006
	(.53)
Special property tax assessment (yes = 1)	.069
	(.76)
Sharelease (yes = 1)	.154[1]
	(5.08)
Cleared land (yes = 1)	1.234[1]
	(402.88)
Drained land (yes = 1)	1.739
	(838.45)
Converted land to cropland (yes = 1)	.241[1]
	(13.68)
Erosion (100 tons/acre/year)	.004
	(2.69)
Land owned (100 acres)	$.240 \times 10^{-5}$[1]
	(26.62)
Land rented out (100 acres)	$-.309 \times 10^{-5}$[1]
	(6.17)
Land rented in (100 acres)	$.102 \times 10^{-5}$
	(1.77)
Northeast	.279[2]
	(3.74)
Corn Belt	.663[1]
	(31.34)
Northern Plains	1.146
	(85.31)
Appalachian	.404[1]
	(9.34)
Southeast	.723[1]
	(26.48)
Delta States	.592[1]
	(17.13)
Southern Plains	1.317[1]
	(115.94)
Mountain	1.047[1]
	(71.73)
Pacific	.492[1]
	(9.94)
r_s[3]	.551

[1]Significant at the 5-percent level.
[2]Significant at the 10-percent level.
[3]Spearman's rank correlation coefficient between predicted probability and the actual response.

The positive relationship between years of formal schooling and the likelihood of investment may indicate that individuals with greater technical and allocative abilities perceive greater gains from soil conservation investments. As a result of their formal education, these individuals may be better able

to interpret information presented by organizations such as the Extension Service and the Soil Conservation Service. Exploring this hypothesis thoroughly would, however, require far more detailed information than is available as length of formal education is an exceedingly rough proxy. This result does suggest, however, that information programs positively influence the adoption of conservation structures.

The coefficients for farm income are positive but insignificant. This result is puzzling because Young and Daugherty, in their analysis of the follow-on survey, found that personal funds were the primary source of funding for conservation investments. Further examination of this issue revealed multicollinearity between farm income and the other investment variables (*16*).

Acreage owned is a positive and significant influence on investment. The positive relationship may reflect cost- and risk-spreading economies—for example, a greater access to capital markets due to greater wealth and a greater probability of holding land requiring erosion-control structures. However, the value per acre of landholdings is not significant in explaining observed variation in investment behavior. Further analysis showed no evidence of multicollinearity between land value and other investments (*16*).

One could expect that special property tax assessments which encourage farmland preservation would increase the likelihood of investments. Nonetheless, the results do not support this expectation.

The soil conservation literature has emphasized the importance of forms of landownership and tenure arrangements as factors affecting conservation investments. Our analysis supports these findings. The share lease parameters are positive and significant. This finding regarding share leases has implications for public policy. The greater probability of investment under share leases may be partly attributable to the tax advantages of conservation investments that Federal tax law provides under share leases relative to those it provides under cash leases (*3*). Erosion control is thereby encouraged. Our results show that the probability of investment in conservation structures is significantly and negatively affected by the amount of land an owner rents to others. This finding conforms to commonly held opinion. The amount of land rented in and operated does not appear to significantly influence the likelihood of investment in conservation structures.

The likelihood of investment in soil conservation structures also varies by region. The productivity of conservation structures depends on climatic, topographic, and soil variations among regions. Regional economic conditions and institutional and social factors may also influence the likelihood of conservation investment. The regression coefficients for farm production regions are all positive and, with one exception, significant. The positive sign simply means that investment in conservation structures is more likely elsewhere than in the Lake States. A ranking of the regression coefficients by magnitude generally indicates that the Southern Plains is the region most likely to have a conservative structure installed; the Northern Plains comes next. The least likely regions to have conservation investment are the Lake States and the Northeast farm production regions.

The parameter for the USLE has the expected sign, but is insignificant. This finding is not surprising as the available USLE data may not accurately measure the erosion hazard on the improved parcels.

Implications

The results of this study support three hypotheses. First, personal characteristics of individual landowners influence adoption of conservation structures. Age, education, and sex are significant factors for conservation investments. Second, tenure arrangements affect the likelihood of investment in conservation structures. There is an inverse relationship between land rented to others and conservation investments. This relationship is partially offset when share leases are used. Furthermore, the likelihood of investment is greater on larger landholdings. Third, conservation structures are more likely to be installed in a package including other land-improving measures. This finding suggests a complementarity between land improvements and conservation structures.

The fundamental implication for policymakers is that attention should be given to the characteristics of landowners, ownership patterns, and the general potential for land improvement when voluntary programs are designed. However, although our analysis indicates the importance of these characteristics,

those evaluating programs need models capable of providing fairly accurate predictions of participation under alternative program designs to exploit such information. Developing these models will require a better data base than is now available. Analysts need detailed data on the types, magnitudes, and timing of investments. They also need more complete data on farm decisionmakers, soil characteristics, farm location, and other factors affecting the economics of soil conservation.

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Effects of Simulated Changes in Consumer Preference on the Meat and Poultry Industries

By Richard Crom*

Abstract

Consumer preferences for meat may be changing; if so, market-clearing retail prices will be higher or lower than if no such changes occurred. It will be several years before statistical analysts have enough price-quantity observations to determine whether these alleged shifts in preference for meat products began in the eighties. This article reports the simulated impacts on the livestock and crops sectors of several combinations of assumed shifts in consumer preference for beef, pork, and frying chickens over a 10-year period.

Keywords

Demand, prices, simulation

U.S. consumption of meat and poultry products has been increasing for many years. Per capita consumption of beef, pork, and chicken rose from only 120 pounds per person (retail weight basis) in 1950 to 183 pounds in 1970 and 192 pounds in 1980.[1] Because of the perishable nature of these products, all production is consumed in the short run at a price which clears the market. In the longer run, consumers' incomes support their tastes and preferences for meat and poultry, and production adjusts to aggregate consumer demand.

Lower real per capita incomes in the early eighties led to lower retail prices of beef, pork, and chicken clearing the markets than they would have if the economy had not been in recession. Consumer preference for meat and poultry products relative to other foods may also be starting to decline slightly. Because numerous observations are needed to verify this hypothesis, it will be several years before conventional econometric analyses can identify the presence or absence of such a demand change. But analysts can conduct simulation experiments on a comprehensive model of the red meat-poultry-feed grain complex immediately to ascertain the effects of a shift in consumer preference on the agricultural sector.

Aggregate consumer preference is the sum of individual preferences. If aggregate consumer preference for meat is changing, it may be a combination of: (1) some consumers not wanting to purchase the product at all (price is irrelevant for this group), (2) some who want to purchase a different quantity than previously at the same level of prices and incomes, (3) some who have not changed their price-quantity reaction but whose incomes have changed, and (4) others who have not changed their levels of consumption given product prices and whose incomes have not changed. Some combination of these shifts in consumer preference and incomes has probably occurred. In the short run, these shifts in demand among the types of consumers identified above require that retail prices be readjusted so that the latter three groups of consumers will clear the market of the predetermined quantity of product produced. In the longer term, production can be adjusted to this change in aggregate demand.

I selected four scenarios to measure the impacts of alternative hypotheses regarding changing consumer preferences for beef, pork, and chicken:

1. Consumer preference is declining for all three meats.

2. Consumer preference is declining for beef and increasing for chicken, with no change in consumer preference for pork.

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[1]Chicken at retail refers to frying chickens (broilers). The retail price index used is for frying chickens only. Other chicken, primarily spent laying hens, is not included.

3. Consumer preference for both beef and pork, the major red meats, is declining, whereas consumer preference for chicken is increasing.
4. Consumer preference for beef resumes its previous upward trend, with no change in consumer taste for pork and chicken.

Method of Analysis

The choice of a model for conducting these simulation experiments involved several criteria: (1) comprehensive coverage of the livestock-feed grain complex, (2) ability to make a 10-year projection, and (3) a structure adaptable to introducing endogenous change.

The U.S. Department of Agriculture's Food and Agricultural Policy Simulator (FAPSIM) (*1, 2*) was selected because it meets all three criteria.[a] It is an annual econometric model containing 360 endogenous and 265 exogenous variables. In addition to estimating equilibrium livestock and crop prices and production, the model also endogenously determines farm production expenses, cash receipts, net farm income, Government deficiency and reserve storage payments, and consumer price indexes for food products.

Livestock commodities in FAPSIM include beef, pork, dairy, chickens, eggs, and turkeys. Each individual livestock submodel consists of a set of equations to estimate production (slaughter), farm and retail prices, civilian consumption, and ending stocks. It also includes equations for predicting the stock of breeding animals, additions to the breeding herd, and slaughter of breeding animals.

The model uses identities to ensure that changes in the number of market animals and breeding animals reflect changes in animal births, deaths, and slaughter. The number of breeding animals slaughtered and additions to the breeding herd are functions of the price of livestock relative to the price of feed and the stock of available animals. The size of the livestock crop is a function of the stock of breeding animals. Livestock slaughter depends on the ratio of the price of livestock to feed costs and on the number of market animals on farms. The livestock and feed grain sectors are linked so that a change in feed demand affects grain prices; conversely, a shift in grain supplies available for feeding affects prices that livestock producers must pay.

Civilian consumption of meat is calculated as total supply less military consumption, exports, and ending stocks. Military consumption, imports, and exports are treated as exogenous. Ending stocks are expressed as a function of total supply and the ratio of current to lagged retail price.

The retail price index of each type of meat is determined by an econometric relationship expressing real retail price as a function of its own per capita consumption, real per capita disposable income, and real retail prices of competing meats. Farm prices of each livestock commodity are expressed as functions of the corresponding retail price index and variables reflecting meat processing and marketing costs.

Crop commodities in FAPSIM include corn, oats, barley, grain sorghum, wheat, soybeans, soybean meal, soybean oil, and cotton. Each crop submodel consists of a set of equations to estimate production, total supply and demand, and ending stocks. Finally, some aggregate indicators of the performance of the agricultural sector such as cash receipts and farm income are calculated.

FAPSIM estimates retail prices for beef, pork, and chicken simultaneously, each as a function of prices of the other two competing meats, income, per capita supply of product available for consumption, and the Consumer Price Index (CPI). For each simulation experiment, I modified the appropriate pricing equations as follows.

Any change in consumer preference is usually a slow, long-term trend—perhaps 1 percent per year at most. So, for these experiments on the model, I decreased (increased) the price estimate by 1 percent per year for each meat for which a demand change was postulated in the experiment, after accounting for changes in per capita supply of product available for consumption, income, and competing meat prices. In other words, I assumed that the market-clearing price was successively 1 percent less each year because of a change in aggregate consumer preference. Because these prices interacted in the simultaneous solution for each time period (year), the final price estimate differed from a 1-percent change each year.

[a]Italicized numbers in parentheses refer to items in the References at the end of this article.

An example may further clarify the model modification. For the experiments where the market-clearing price of beef was assumed to decrease by 1 percent per year (not including an adjustment for inflation) from the baseline value over the 1982-91 simulation period, I took the 1982 value of the retail beef and veal index (2.74) as an initial value. Then, I reduced the intercept of the price-estimating function by an amount equal to 1 percent (of the beef and veal index) for 1982 (0.027). For 1983, the reduction in the intercept was 2×0.027, plus an adjustment (increase) for inflation. The 10th-year adjustment (1991) was $10 \times 0.027 = 0.27$ plus the increase for inflation of 1.59 ($0.27 \times 1.59 = 0.43$).

Because the annual FAPSIM model is recursive (or block recursive), it can be used to simulate the agricultural economy for a period of years. The model was allowed to run for 10 years (1982-91) to simulate the dynamic supply and further price-supply interactions within the livestock sector and the interaction with the crops sector. Then, I compared the simulated prices and outputs with those of the base projection of the model.

Model Baseline

Overall, the baseline values of the projected variables indicate directional trends, mostly moderate increases due mainly to inflation and population growth. However, their chief function in this analysis is to serve as a base for measuring changes that occur as the model is "shocked" with a combination of changing trends in the functions used to estimate annual values of market-clearing retail prices.

The FAPSIM model was given initial endogenous data and projected exogenous data to operate it through 1991. This 10-year projection provides baseline estimates of the price-production sequence in the crops-livestock sectors which one can use to compare the projected estimates of prices and production under the postulated alternatives.[3]

These model experiments are performed in a projection time frame for two reasons: (1) information is provided relative to the possible nature of future events, and (2) the estimates are not affected by historical shocks because of aberrations in the exogenous variables. Therefore, the projected variables usually show less cyclical and seasonal volatility when I compare them with their historical values.

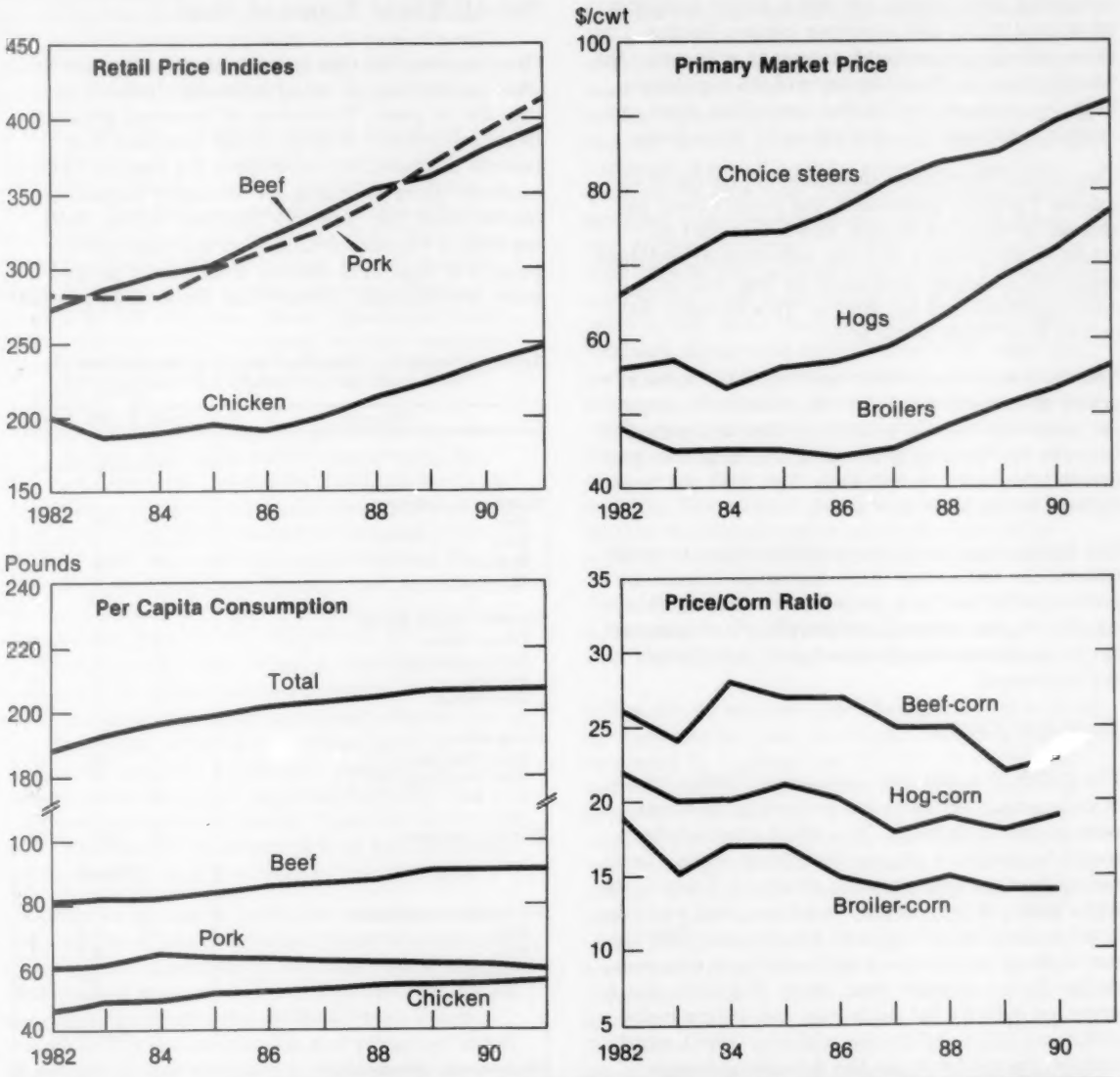
Projected values of beef, pork, and chicken retail price indexes, primary market prices, price-corn ratios, and per capita consumption are shown in the figure. The projected baseline prices increase substantially, especially after the mideighties, as inflation moderates. However, the price-corn ratios decrease because meat prices actually decrease in real terms, whereas the corn price holds rather constant when deflated. All values of the price-corn ratio for cattle, hogs, and broilers fall in an "indeterminant" range which provides no signals for rapid expansion or contraction of production. Thus, the projected beef cow inventory increases gradually from 40.5 million head in 1982 to 50.5 million head in 1991, with the rate of increase slowing toward the end of the period. The inventory of hogs kept for breeding increases and then declines somewhat, but holds around 9.1 to 9.3 million head.

Per capita consumption of the three types of meat increases moderately from just under 190 pounds, retail weight basis, to 207 pounds at the end of the 10-year period. Overall, projected beef and chicken consumption increases (see figure), whereas pork consumption declines after an initial increase. The combined increase in per capita consumption of only 19 pounds is the result of the compensating shifts among the three types of meat and the pressure of increasing population on the production base.

Projected values of several other variables serve to measure the performance of the agricultural sector over this 10-year simulated baseline projection. The Consumer Price Index for Food increases from 288 to 439, just over a 5-percent average increase per year. The percentage of beef production that came from fed cattle ranged from 72 to 77 percent. Corn used for feed was 4.2 billion bushels in 1982 and increased to 4.6 billion bushels in 1990. Net farm income increased in nominal terms, but decreased in real dollars.

[3]The baseline projections do not represent official U.S. Department of Agriculture forecasts, but are used only to compare alternative scenarios.

Model Baseline



Simulated Experiments Reflecting Changes in Consumer Preference

I performed four experiments involving demand shifts on the model, each beginning in 1982 and ending with the 10th year of the projections (1991). The experiments represent varying combinations of changing consumer preference for the three types of meat.

The first experiment, which probably represents a maximum decrease in demand, simulates the effects

of a 1-percent decrease per year in the estimated price of each of the three types, after accounting for competing meat prices, per capita supply available for consumption, and consumer income. Such a price reduction is assumed necessary to increase the consumption by other segments of the population after one segment had shifted away from meat consumption because of a preference for other foods.

The second experiment simulates the effects of an annual 1-percent decrease in the price of beef, no change in the price of pork, and a 1-percent increase in the price of chicken, reflecting an assumed declining consumer preference for beef and an increasing preference for chicken. This scenario may be the most likely of the four.

The third experiment is a variation of the second; prices of both red meats are decreased by 1 percent per year, whereas the price of chicken is assumed to increase by 1 percent per year. Here, consumer preference is assumed to shift away from both red meats in favor of chicken.

The fourth experiment represents a return to conditions of the sixties and early seventies—consumers' preference for beef is assumed to increase. In this simulation, the price of beef increases by 1 percent per year, whereas the prices of pork and chicken are unchanged.

Empirical Results

The FAPSIM model was given initial (1981) values of endogenous variables and projections of exogenous variables through 1991, which enabled the model to produce a 10-year simulation of the alternative changes in the pricing structure. Table 1 presents values of the relevant variables; some variables listed under the 1991 column heading are 1990 values as these variables are estimated on a crop-year, rather than a calendar-year, basis. The table shows projected data for the beginning and ending years (1982 and 1991) and for the midpoint (1986), which enables the reader to see the developing trends without having to consider all 10 years of simulated values. Price changes are expressed as a percentage change from the baseline projection. Changes in consumption are presented as absolute values. Values of price-corn ratios are shown as their absolute percentage values, since the general upper and lower limits of these values which lead to production change are established.

Scenario 1: Consumer Preference Declines for All Three Types of Meat

One can simulate this decrease in consumer preference by reducing all retail prices by 1 percent per year for 10 years. The values of the retail price indexes are reduced slightly in the first year, but become progressively lower from the base as further 1-percent price decreases are necessary to clear the market each year (table 1). The final values, ranging from a 15-percent decline in the retail pork price to a 25-percent decline in the retail chicken price, are obviously greater than the total 10-percent

Table 1—Scenario 1: Results of reducing retail prices of beef, pork, and chicken by 1 percent per year

Variable	1982	1986	1991
	Percentage change		
Retail price indexes:			
Beef	−2	−10	−17
Pork	−6	−7	−15
Chicken	−3	−12	−25
CPI: food	—[1]	−2	−4
Primary market prices:			
Choice steers	−12	−11	−23
Barrows and gilts	−3	−10	−25
Broilers	−2	−7	−19
Corn (farm)	0	−4	−18[2]
Inventories:			
Beef cows, Jan. 1	0	−2	−7
Hogs (breeding), Dec. 1	0	−3	−5
Corn fed	−2	−6	−5[2]
Net farm income	−6	−25	−29[2]
	Pounds		
Per capita consumption:			
Beef	−.2	−1.5	−4.7
Pork	0	−2.1	−3.4
Chicken	−.1	−1.2	−2.1
Total	−.3	−4.8	−10.2
	Ratios		
Performance indicators:			
Beef-corn ratio	25	24	22
Hog-corn ratio	21	17	16
Broiler-corn ratio	18	13	12
	Percent		
Portion of beef fed	73	74	71

[1]Sign indicates direction of change, but value is less than 1 percent.
[2]Data for 1990.

reduction built into the pricing structure. This result occurs because retail prices are estimated by a simultaneous solution which allows interaction of the prices of competing meats each year. Overall, these lower meat prices reduce the CPI for food by 4 percent below the baseline value after 10 years.

Primary market prices are reduced somewhat more in percentage terms, generally by about 20-25 percent. This somewhat greater percentage change is due to no change in exogenous variables affecting the marketing cost and the magnitude of the base value from which the percentage change is calculated. The farm price of corn eventually falls by 18 percent by the 10th year, which reflects the reduction in the amount of corn used for feed, which declines by 5-6 percent below the baseline after the first few years.

Because both primary market prices and the corn price decline in roughly similar proportions, the price-corn ratios do not change nearly so much as meat prices. All price-corn ratios remain in an indeterminate range. Beef production is usually not affected if the beef-corn ratio stays between 20:1 and 25:1. Hog production usually does not increase until the ratio exceeds 24:1 and is usually not curtailed drastically until the ratio falls below 16:1. The broiler-corn ratio did not change much from the baseline ratio. Thus, relative profitability of livestock and poultry production was not affected enough to induce major shifts in production patterns. This finding is supported by the data showing that basic breeding inventories changed substantially less. Beef cow numbers declined by 7 percent in the 10th year, whereas the inventory of hogs kept for breeding declined by only 5 percent by the 10th year.

The smaller change in inventory caused per capita consumption of the three major types of meat to decline by only 10 pounds by the 10th year of the simulation. Beef consumption declined most per capita, and chicken consumption declined least. The portion of beef produced from fed beef remained above 70 percent in this alternative, which is similar to that in the baseline.

Net farm income dropped substantially (as much as 29 percent by the 10th year) because of the drop in prices and in cash receipts of both livestock and feed grains.

Several implications can be drawn if prices do fall as they did in this experiment because of a decrease in consumer demand. First, prices drop for consumers, but the availability of meat for consumption does not fall correspondingly. Consumers who remain in the market will actually have a larger meat supply. Meat production will probably fall more in future years if the trend continues, since production adjustment to lower price effects should increase in later years when prices drop by at least 5 percent. Although primary market prices are down by the fifth year, livestock producers are not yet faced with disaster because feed input prices also dropped; however, livestock production would definitely be less profitable than under the baseline alternative. Feed grain producers will be affected by lower prices, which demonstrates the importance of livestock, along with export demand, as major demand factors in feed grain markets. Feed grain prices fall principally because grain production was not lowered perceptibly even by the 10th year, although feed grain use was down by 5 percent or more by the fifth year of the simulation. Under this scenario, Government policy supporting grain production through target prices would have to be adjusted to avoid a large buildup in grain stocks.

Scenario 2: Consumer Preference Decreases for Beef and Increases for Chicken

In the second scenario, retail beef prices are reduced by 1 percent per year, and retail chicken prices are increased by 1 percent per year for 10 years. This scenario portrays the results of a slight decline in preference for beef with a rising preference for chicken. Some industry analysts consider this scenario more likely than the baseline. Note that pork pricing is unchanged. As a result, the retail price index for pork declined by only 3 percent by the end of the simulation period; it was brought down by lower beef prices which fell by 11 percent by the 10th year (table 2). Despite the increase in chicken prices (1 percent per year over the baseline), the final price effect was only a 1-percent increase in the chicken price by the 10th year. In the simultaneous solution, the declining beef price negates the rise in chicken prices. Because of the counter effects of these variables, the CPI for food fell only slightly during the period.

Primary market prices reflected the same pattern, with Choice steer prices declining the most (17 percent by the 10th year). Corn prices again fell by 8

Table 2—Scenario 2: Results of changing retail price of beef (1-percent reduction per year) and retail price of chicken (1-percent increase per year)

Variable	1982	1986	1991
	Percentage change		
Retail price indexes:			
Beef	−1	−6	−11
Pork	—[1]	−1	−3
Chicken	+	+	+1
CPI: food	0	−1	−2
Primary market prices:			
Choice steers	−1	−9	−17
Barrows and gilts	−1	−3	−7
Broilers	+	+	+1
Corn (farm)	0	−4	−8[2]
Inventories:			
Beef cows, Jan. 1	0	−1	−5
Hogs (breeding), Dec. 1	0	−1	−1
Corn fed	−1	−2	−2[2]
Net farm income	−2	−12	−20[2]
	Pounds		
Per capita consumption:			
Beef	−.1	−.9	−3.2
Pork	0	−.4	−.1
Chicken	0	+.3	+.8
Total	−.1	−1.0	−2.5
	Ratios		
Performance indicators:			
Beef-corn ratio	26	25	21
Hog-corn ratio	20	20	19
Broiler-corn ratio	19	16	15
	Percent		
Portion of beef fed	73	75	70

[1]Sign indicates direction of change, but value is less than 1 percent.
[2]Data for 1990.

percent because of lower feed grain demand, which declined by 2 percent after the fifth year.

Because of lower feed prices corresponding to the drop in livestock prices, the price-corn ratios remained in the intermediate range during the entire simulation period. Thus, inventory response was considerably less than the price change, with beef cow numbers finally falling 5 percent below the baseline projection at the end of the period and with most of the change coming after the fifth year. The change in the number of hogs kept for breeding was minimal. Because the change in basic production inventories was less than under the first scenario, per capita consumption of beef, pork, and chicken declined by only 2.5 pounds by the 10th year. Beef consumption fell 3 pounds per capita, but was offset somewhat by a slight increase in chicken consumption.

Net farm income fell by 20 percent by the end of the period because of a major decline in Choice steer prices and a decline in corn prices.

The major implication of this scenario is that consumers would enjoy substantial price reductions with little change in meat availability. In fact, those who remained loyal beef consumers would probably find an increase in beef availability. If the trend were to continue, lower beef prices would reduce pork prices, but chicken prices would change little, even though chicken consumption increased. Although net farm income is not down so much as under the first scenario, the 20-percent drop reflects a loss of income by both beef producers and grain farmers, again demonstrating the importance of feed use by livestock on corn prices and indicating a rather slow response by corn producers to change production, even when feed demand is down. Finally, this scenario shows that market structure is more affected by a change in beef prices than by a change in pork and chicken prices.

Scenario 3: Consumer Preference Decreases for Beef and Pork, but Increases for Chicken

In the third scenario, both beef and pork prices are reduced by 1 percent per year, whereas chicken prices are increased by 1 percent per year for 10 years. This alternative is a variation of the previous scenario, as the prices of both red meats (beef and pork) are postulated to be affected by the change in consumer demand in favor of white meat. Simulated data for this alternative are not shown in tabular form, as this scenario is a variation of scenario 2.

Under scenario 3, beef prices are reduced a little more by the 10th year (by 14 percent, as compared with 11 percent) compared with those under scenario 2, and pork prices fall by 12 percent at the end of the period. However, because of the interaction of red meat prices on chicken prices, the price of chicken decreases by 5 percent at the end of the period, compared with a 1-percent increase in chicken prices at the end of the period under scenario 2. The CPI for

all food declines moderately, to 3 percent by the end of the period.

Again, the price-corn ratios are in the intermediate range, so that inventories are changed much less than prices. Therefore, per capita beef consumption fell by 4 pounds at the end of the period, and pork was down by 3 pounds. Chicken consumption increased by only 1 pound by the 10th year because of the price decline induced by falling prices of red meat. Consumption of all three meats fell 6 pounds by the 10th year.

Net farm income fell slightly more than under scenario 2 because hog prices also declined. The implications of scenario 3 are similar to those of scenarios 1 and 2. However, the decline in both red meat and chicken prices reinforces the implication of the previous scenario, indicating that prices of red meats affect chicken prices far more than chicken prices affect red meat prices.

Scenario 4: Consumer Preference for Beef Increases

In the fourth scenario, the retail beef price is increased by 1 percent per year for 10 years. This scenario, which represents a return to growth in demand similar to that in the sixties and early seventies, portrays a complete turnaround in price and production statistics. The retail beef price index increases by 14 percent at the end of the 10th year; it also raises retail prices of pork and chicken 5 and 10 percent, respectively (table 3). The CPI index for all foods increases by 2 percent at the end of the period.

Primary market prices also increase more, caused by changes in both the percentage base calculation and the likely narrowing of the price spread. Thus, Choice steer prices increase by over 30 percent in the 10th year, and hog and broiler prices increase by 15 percent or more. Because of the stronger demand for feed grains (that is, corn feeding increases by 2 percent), corn prices on farm increase by 11 percent by the 10th year.

Price-production ratios tended to remain near the upper levels of the indeterminate range for signaling production change, although the beef-corn ratio (which is particularly high in the early years of the simulation) induced an expansion in beef cattle numbers by about 4 percent.

Because of improved prices and profitability of livestock production, per capita consumption of the three types of meats increased by slightly more than 4 pounds, with about 75 percent of that increase for beef. The portion of beef fed was the highest under any scenario, generally exceeding 75 percent of beef production.

Table 3—Scenario 4: Retail price of beef increased by 1 percent per year

Variable	1982	1986	1991
	Percentage change		
Retail price indexes:			
Beef	+1	+7	+14
Pork	+1	+2	+5
Chicken	+1	+5	+10
CPI: food	+[1]	+1	+2
Primary market prices:			
Choice steers	+2	+10	+31
Barrows and gilts	+1	+5	+18
Broilers	+1	+7	+14
Corn (farm)	0	+4	+11[2]
Inventories:			
Beef cows, Jan. 1	0	+1.1	+4.4
Hogs (breeding), Dec. 1	0	+	+
Corn fed	+1	+2	+2[2]
Net farm income	+3	+14	+25[2]
	Pounds		
Per capita consumption:			
Beef	+.1	+.8	+2.7
Pork	0	+.6	+.9
Chicken	0	+.4	+.5
Total	+.1	+1.8	+4.1
	Ratios		
Performance indicators:			
Beef-corn ratio	27	28	24
Hog-corn ratio	22	20	18
Broiler-corn ratio	19	16	14
	Percent		
Portion of beef fed	74	78	74

[1]Sign indicates direction of change, but value is less than 1 percent.
[2]Data for 1990.

Higher prices obviously increased net farm income by as much as 25 percent at the end of the period, with both livestock and grain producers sharing the increased profits.

Under this scenario, primary producers of livestock and poultry would enjoy better incomes, with consumers facing higher prices for minimal quantity increases. The increase in feed prices again reflects the positive effects of domestic livestock on the total demand for corn, and the carryover effects of increasing beef prices on the hog and broiler markets reemphasize the dominant effect of beef in the meat price structure.

Implications

The major conclusion of these experiments is that there is considerable inertia in the supply response of the total system. Although the simulated prices changed rather rapidly in response to changing market conditions, change in livestock production was slow mainly because of small changes in relative profitability, as feed prices also fell. It was surprising that corn production adjusted minimally, even after a substantial change in the corn price. This finding probably reflects a production structure in which producers have limited alternatives for land use, so they maintain production to bolster cash receipts as long as they can cover variable costs. Furthermore, the existing price-support program (target prices) tends to maintain grain production.

Beef prices drive the total livestock production system and dominate the pricing structure, even when the beef price (pricing structure) is reduced and the chicken price is increased. Because of the slow change in supply response, consumers would not suffer from lack of product availability nearly so much as they would from having to pay more for the small changes in the quantity of product available.

Given expected future increases in population after the simulation period (1990 and beyond), population numbers will probably put pressure on the production system. Thus, a slight shift in demand from beef to white meat might help maintain price stability and product availability.

If the scenarios depicting a decline in consumer preference for either all meat or for only red meat do develop, many livestock and poultry producers could probably remain in business, but profitability would be reduced to minimal levels—just high enough to keep resources in livestock production. If export demand for grains increased to offset declines in feed use, higher grain prices would lower meat production at a faster rate than indicated in these simulations.

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Research Review

Groping in the Dark

**Donella Meadows, John Richardson, and Gerhart Bruckman.
New York: John Wiley & Sons, 1982, 311 pp., $26.95.**

Reviewed by Robert B. Rovinsky*

Groping in the Dark is an important, interesting, often insightful, and occasionally frustrating book.

In less creative hands this volume would have been one more dry, esoteric conference proceedings, in this case the Sixth Symposium on Global Modeling sponsored by and held at the International Institute for Applied Systems Analysis (IIASA) in Austria. That conference brought together all the global modelers of the preceding 10 years, from the original Club of Rome teams (Forrester/Meadows and Mesarovic/Pestel) in the early seventies to the more recent attempts by European, Asian, Latin American, and United Nations groups. What Meadows, Richardson, and Bruckman have done is to transform the format and the content to produce a modern Platonic symposium, a freewheeling Chautauqua of a book.

Coleridge once wrote that poetry (and the other arts by extension) requires a "suspension of disbelief." A similar suspension is required to fully achieve and appreciate the authors' purpose. For many of us, accustomed to reading critically and expecting rigor and specificity in research publications, this book would be all too easy to put down, in both senses of the phrase. However, there is much to gain by a careful, but accepting, journey into this strange book.

Most books about systems analysis and modeling make at least passing reference to the need for interdisciplinary research, multiple frames of reference, and the connections between form and content. Meadows and her coauthors not only wax passionately about these topics, but have designed the book to reflect their beliefs. Thus, the book itself is printed in four colors—with yellow pages for their personal thoughts, blue for the conclusions of the conference, white for the proceedings themselves, and gold for tutorial materials on the field of global modeling. Because the book is also written for three types of readers—modelers, policymakers, and the general public—the tone also varies considerably, as it tries to keep all of its readers involved almost all of the time. And yet it works in much the way that any book about an important new subject works; we read it and forgive or ignore the difficulties because the subject is extremely important and the authors have something to say.

The Sixth International Conference was intended to review and assess the seven major global models developed up to that time (1979). These models are: (1) the Forrester/Meadows model, developed in 1970-72 at MIT; (2) the Mesarovic/Pestel model, developed in 1972-74 at Case Western Reserve University; (3) the Bariloche model, developed in 1970-74 at Fundacion Bariloche, Rio Negro, Argentina; (4) the MOIRA model, developed in 1972-75 at the Free University in the Netherlands; (5) the SARU model, developed in 1974-76 at the Systems Analysis Research Unit, London; (6) the FUGI model, developed in 1973-76 at Tokyo University; and (7) the United Nations World Model, developed in 1973-76 at New York and Brandeis universities.

The models differ widely in terms of their discipline, model paradigm, and underlying purpose and philosophy. Most were interdisciplinary, and collectively the seven core teams included 12 engineers, 10 economists, 6 physicists, 8 biological scientists, 3 mathematicians, 2 political scientists, and 1 educator. Model paradigms ranged over systems dynamics, input/output, econometric, optimization, and classical economic. Some models were technology-driven, others price-driven, still others were population-driven. However, as the authors conclude, "global models were mechanistic and simple when it came to political, cultural, and organizational matters . . . yet in most of the models (even those developed by engineers), economic variables have been given overwhelming emphasis."

Before the conference, each modeler was given a questionnaire to complete on the underlying assumptions, methodology, organization of the team, results, publication, purpose, and assessment of the model. These completed questionnaires were circulated before the conference to all participants, and the sessions organized around these themes. Each session

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had a rapporteur, and the major portion of the book (white part) is taken up with these questionnaires and the rapporteur's comments.

Why should social scientists read this book? First, because it represents one of the clearest and most accessible statements about what global modelers have to say about the world. Second, it contains a clear exposition of the terms, jargon, techniques, and professional and personal history of the efforts in this field over the past 15 years. Third, because it contains useful data, summaries, and methodologies which can be directly used in general economic research areas (including, but not limited to, the specific fields of econometrics and simulation). Of special interest to agricultural researchers is the effort of global modelers to grapple with the overwhelming amount of data in some areas of their models and the paucity of data in other areas. And, finally, the authors' style allows critical reading by making the field of global modeling and the world models produced thus far relatively accessible to the reader. Too often books are so difficult to read that the reader's critical facility is eclipsed by the effort required to comprehend difficult or poorly presented ideas. Such is not the case here; the book is a delight to read or skim.

What makes this book frustrating, however, is just how little has been achieved, compared with what has been expected or promised. Again and again, the authors and conference participants repeat a litany of doubts, failures, unrealized expectations, wrong turns, "where do we go from here" statements, and so forth. Nowhere is there an "aha" or a "eureka." What there seems to be is a partial failure of will, which may be understandable given the problems IIASA and its colleagues have in this age of a renewed cold war and reduced funding. Yet, I looked for more excitement and hope. Yeats wrote in "The Second Coming" that "the best lack all conviction, while the worst are full of passionate intensity." Could our best modelers (and our best social scientists) be drowning in a sea of data, linkages, and wave after wave of connecting ideas, consequences, causes, and effects?

But never mind the quibbles. Get and read this book, if only for its insights, its cleverness, and its colored pages.

Beef in Japan: Politics, Production, Marketing and Trade

John Longworth. Brisbane, Australia: University of Queensland Press, 1983, 327 pp., $25.

Reviewed by Bill Coyle*

John Longworth's book, *Beef in Japan*, appears at an opportune time. Australian and U.S. negotiators are trying to pry open what has been an extremely restrictive Japanese beef market. A U.S.-Japanese agreement on beef and citrus products (which expired on March 31, 1984) widened the door somewhat, but principally provided a niche for U.S. grain-fed beef and stabilized Japanese beef imports at a relatively low level of 120,000-130,000 metric tons (mt) per year for 1979-83. Before that, imports had been erratic; they rose to 127,000 mt in 1973 and were curtailed altogether the following year. Readers of Longworth's book will gain an appreciation of how complex the Japanese beef market is, why beef is so important to the Japanese, and what political obstacles the U.S. and Australian negotiators face. The book also contains considerable detail on the historical developments that have shaped the current Japanese market and that will influence its future.

Japan's unwillingness to open its beef market comes down to politics. On grounds of economic efficiency, Japanese beef production is costly to the economy. High support prices protected by trade restrictions misallocate land, labor, and capital resources. It is perhaps surprising to the casual observer that an efficiency-minded Japan does not pursue a more economically rational course for beef that would, as some studies have shown, boost the country's economic welfare. But, an economically rational approach to beef production or to several other agricultural industries has not generally been espoused. As Longworth points out in some detail (chapters 3 and 7), it is "political considerations, not economic factors [that] control the Japanese beef market" (p. 298).

Japan's restrictive trade policies on beef are part of a broader commitment to the protection of its agriculture. Preservation of an agricultural base in Japan, as in many countries, is perceived to be in its national interest. That interest is currently articulated by the ruling Liberal Democratic Party (LDP) which derives much of its political strength from rural districts delineated after World War II when Japan had a predominantly rural character. The LDP is kept on its toes because other political parties, in competition for the rural vote, offer agricultural policies which are often even more protectionist. Over the years rural political power has led to various farm programs which have often restricted imports and have generally improved the welfare of Japan's rural communities.

The Japanese beef sector, like so much of Japan's agriculture, is characterized by small-scale, high-cost operations. The average Japanese beef herd is only seven animals. And, although Japanese beef production is generally a sideline activity accounting for relatively little farm income, beef producers have succeeded in obtaining substantial Government protection. The political success of its beef producers is attributable to their large numbers and close ties with the dairy industry and to agriculturewide and general public sympathy for agricultural protection.

Furthermore, the farm cooperative, Nokyo, with sizable investments in slaughter, processing, and input supply industries, has a large economic stake in protecting local beef production. The Livestock Industry Promotion Corporation (a state trading agency that administers beef import quotas) allows some wholesale distributors (including the Dowa, a minority group closely associated with the meat trade) to purchase foreign beef below the wholesale price of equivalent-quality domestic beef. These distributors, along with pork and chicken producers, have an interest in high beef prices. These interests through various organizations, associations, and Government bureaucracies have created a "web of influence" that goes to the apex of Japanese politics and that is, indeed, formidable.

There are some countervailing forces, however. They are consumer groups (not very strong and beef prices are a low priority), business groups (Keidanren with close connections to the LDP) who see their overseas markets threatened by possible retaliation

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because of Japan's agricultural protection, the labor unions (compromised to some extent by support for the Dowa), and certain Government ministries (Foreign Affairs (MFA) and International Trade and Industry (MITI)) that take a broader view of Japan's welfare.

Longworth provides only a faint glimmer of hope that the balance of political power will shift against the beef interests: "If, at some time in the future MITI, MFA, and other groups . . . all decide to insist that the Government liberalize beef imports, then MAFF, the farmers, and the traditional meat trade may be hard pressed to defend the status quo" (p. 78). U.S. pressure could catalyze a shift in support toward a more liberal position (for example, replacement of import quotas with a deficiency payment scheme). However, the beef issue is only one facet of a complex trade and political relationship between the United States and Japan. U.S. pressure to liberalize the Japanese beef market could be easily weakened by Japanese concessions in other problem areas such as automobiles or defense.

Although political forces "control" the Japanese beef market, other important forces will also affect its future shape—namely, dietary changes (chapter 1) and certain constraints on expanding beef production (chapters 4 and 5).

Beef consumption in Japan grew rapidly after World War II, but remains on the periphery of the Japanese diet. (Annual consumption is only 3.5 kilograms per capita.) Despite low levels of per capita consumption, the Japanese beef market as a whole is quite large because of Japan's large population. It is, therefore, reasonable to disaggregate the beef market, as Longworth has, into three submarkets.

At the top (6 percent) is the super-grade beef known as Kobe, Matsusaka, or Omi, which comes from the native Wagyu breed. There is a broad middle-grade market for "popular" beef (65-70 percent) as well as a sizable market for processing beef (30 percent). Each of these markets has distinct characteristics and will likely respond differently to future economic conditions. For example, Longworth says that the popular grades of beef are no longer considered a luxury by many Japanese; therefore, the income elasticity has probably fallen and the own-price and cross-price elasticities of demand may have increased. As a result, the large "popular beef" market will probably not be as responsive to future increases in income as it has been in the past.

Changes in tastes and preferences will also be important. As long as beef is thinly sliced and boiled or broiled in the dining area (as in shabu shabu or sukiyaki), it will have to be well marbled with fat to prevent it from becoming like shoe-leather. Japanese concern about visual and olfactory aspects of food presentation will sometimes limit demand for grass-fed beef, which tends to have yellowish fat and a sulfurous odor when cooked. But, Longworth says that the advent of barbecue, stews and curries, and mince preparations has made fat color, marbling, and odor less important. This trend coupled with consumers' concern about high dietary levels of saturated fat suggest that demand for a leaner product may grow, a development that would favor Australian beef producers.

In production, we find that even if the Government continues to protect the beef industry as in the past, prospects for future expansion appear quite limited. The principal constraints on expansion seem to be the inherent inefficiencies in the traditional small-scale Wagyu sector and the increasing dependence of the beef industry on calves and culls from the dairy herd (whose inventory is limited by growth in demand for dairy products which is likely to be slower than growth in demand for beef). Another limiting factor is the relatively high cost of feed and limited pasture area which will continue to be a problem unless there is a "sudden and unanticipated breakthrough on the production of feed rice" (p. 275).

The author does suggest that there is room for improved efficiency in Japan's beef industry by lowering the death rate of young dairy calves, increasing the conception rate of the Wagyu, and improving weight gain performance of Wagyu calves. The constraints on the supply of dairy feeder calves could be partly circumvented if the country's capacity to import and quarantine live animals were increased and if the number of cull dairy cows and heifers used exclusively for breeding and calf rearing were expanded. However, the reader is unsure about how these measures might contribute to expanding the country's production potential for beef; again, much has to do with the role the Government will play. The adoption of more efficient practices in the Japanese beef industry will depend on how Government

policies affect competition in the market place. The main factors currently affecting profitability—prices of feed, feeder calves, and the final product—are influenced, to a greater or lesser extent, by the Government.

And so the future of the Japanese beef industry will depend heavily on the Government which, guided by political pressure, can choose among a number of options from maintaining the status quo to adopting a more liberal approach. Beef-supplying countries will benefit from policies that lead to an expansion of import quotas—a likely course given Japan's substantial demand potential and the relatively severe constraints on expanded beef supply. The final question is not so much whether Japanese beef imports will be expanded, but rather by how much.

Longworth's book is an impressive contribution to the unusually limited collection of English language books and studies on Japanese agriculture, a collection which has been growing in the past 5 years thanks to a few Australian and even fewer American scholars. The book does have shortcomings. At times the reader is overwhelmed with detail, perhaps a forgivable sin as the subject is a complicated one that probably defies simple description. Furthermore, it is better to have too much detail than too little on a subject that, to date, has been scantily analyzed.

The last chapter, "Looking into the Crystal Ball," is somewhat disappointing. The author misses an opportunity to bring together the disparate aspects of his subject. What we end up with is a loose summary and a discussion of the plausibility of official Japanese projections of its beef market. It would have been better if the author had provided the reader with his own set of projections, giving weight to the possibilities and uncertainties about which he is so well versed.

Finally, as a political economic study, some of the political analysis is based on limited evidence. Longworth's discussion of trade developments suggests that the rise of the U.S. share of Japanese beef and beef offal imports has to do partly with political and administrative decisions in addition to price and quality considerations. Longworth provides little detail on how these decisions are made and the extent to which they are intended to be discriminatory.

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